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U.S. Department of Transportation Dockets
Docket No. FAA-1999-6411; Notice No. 99-18
400 Seventh St, SW
Room Plaza 401
Washington DC 20590

FAA-99-6411-36

Dear Sir,

ATTENTION DOCKET NO: FAA-1999-6411; NOTICE NO. 99-18
TRANSPORT AIRPLANE FUEL TANK SYSTEM DESIGN REVIEW, FLAMMABILITY REDUCTION, AND MAINTENANCE AND INSPECTION REQUIREMENTS

Originally, the Notice requested comments by 27 January 2000 and UK CAA submitted comment on the Notice of Proposed Rulemaking to comply with that time-scale. The SFAR comment date has been extended by 60 days from the original publication date to cater for comment on associated Advisory Circular proposals. Please accept the comments attached below on the AC material associated with the Notice of Proposed Rulemaking, along with the original comments on the SFAR for completeness.

Thank you for the opportunity to take part in your rulemaking process.

Yours faithfully,

M Poole
Requirements and Policy Unit

CAA COMMENTS ON THE FAA PROPOSED RULE FOR 'TRANSPORT AIRPLANE FUEL
TANK SYSTEM DESIGN REVIEW, FLAMMABILITY REDUCTION, AND
MAINTENANCE AND INSPECTION REQUIREMENTS'.
NOTICE 99-18.

This document gives the comments made by the Civil Aviation Authority on the above FAA Rule-making proposal. These comments are complementary to those submitted by the Authority members of the JAA Powerplant Study Group (PPSG).

The FAA proposal includes changes to certification, design and operational requirements for certain types of Transport Category aircraft. The package of requirements is referred to in this comment document as the SFAR (Special Federal Aviation Regulation), although strictly this term only relates to the Part 2 1 Certification aspects.

The SFAR is proposed so that:
(i) new design requirements for the prevention of fuel tank ignition sources are introduced,
(ii) there will be a review of the fuel system design for previously certificated aeroplanes – i.e. those currently in-service – to the new design requirements and to the current safety assessment rules. If these requirements cannot be met, design changes will be necessary. The review is also expected to identify the necessary maintenance actions, to ensure continued safe operation.
(iii) additional new fuel tank design requirements, for the minimisation of flammable vapours in the tank, are to be introduced for the certification of new aeroplanes.

It is understood that the FAA plan to introduce two new Advisory Circulars, to provide background information and acceptable means of compliance for the new 'ignition source' and 'flammability' reduction design requirements. Comments on these Acs are given at the end of this document.

COMMENTS ON THE SFAR NPRM

General Comments

Although this package of requirements should improve the level of safety for the existing fleet and for newly certificated aircraft, it is possible that, by combining the two activities into a single proposal, some potential benefits for future designs will be missed. It is generally well understood that there is a far greater scope for design (safety) improvements, if the improvements can be integrated into the initial design, rather than trying to modify an existing design. The SFAR identifies a number of current design features, which have shown deficiencies in service. It may be possible to eliminate some of these design deficiencies for new designs, but for existing designs, the service experience may not warrant such drastic action.

2. The proposals given in the SFAR are extensive and could need interpretations and/or means of compliance for some requirements, which have not been used before in the fuel tank safety context. The PPSG have previously written to JAA Headquarters, strongly recommending that this activity should be carried out in a Harmonised way, together with JAA. In making this proposal, it is not intended that a new ARAC Harmonisation Working Group is needed; much of this work could be carried out by correspondence and co-operation between the Authorities. The main benefits for this kind of approach, given in the letter were:
- the FAA/JAA intention to harmonise Part 25 Codes and to prevent future divergence,
- creation of a unified, agreed course of action for reviewing fuel tank safety of the existing fleet,
- minimisation of burden to industry, including avoidance of duplication of work,
- FAA and JAA did work together on the Fuel Tank Harmonisation Working Group,
- the possibility that FAA might delegate, to JAA National Authorities, some of the SFAR compliance determination,
- agreement to a uniform method of compliance with the Safety Assessment requirements for fuel systems and
- joint activity to agree the necessary material to be included in the AC/ACJ material.

Existing Regulations/Certification Methods

3. In this Section, there is a discussion about the methods for assessing the safety of (power-plant) systems. Although the safety of fuel tank systems, from a fire and explosion hazards standpoint, has generally been controlled by specific design requirements and equipment qualification, there are good technical arguments for assessing the safety aspects of fuel tank systems in future, to the same methods used for other aeroplane systems. The Harmonised version of §25.901(c) will require the power-plant installation, including the fuel tanks, to meet the requirements of §25.1309. AC/ACJ material for both §25.901(c) and §25.1309 will give advice on the acceptable methods to be used in performing the analysis. However there is some concern that application of these requirements to the existing fleet may identify many 'non-compliances', which could result in many modifications. Whilst this is not unacceptable in a general sense, if necessary for safety, it is not at all clear that the service experience warrants such drastic changes for the existing fleet. The following detailed questions arise:

- The SFAR states that 'single failures will not jeopardise the safe operation . ..' and 'latent failures have to be assumed'.
- There are a number of single failures identified in the SFAR, which have demonstrated, or have, the capability to create an ignition source within the fuel tank. How will these features be found acceptable to meet the retrospective application of safety assessment requirements? Examples include:
  - various mechanical pump failure modes
  - various electrical pump failure modes
  - arcing of pump power cables to the conduit
- There are a number of single failures within the above examples, which according to the current application of §25.1309 - '... failure of any single component should be assumed . . . and not prevent Continued Safe Flight . ..' would not be acceptable to show compliance.
- Is the FAA expecting modifications to cover all these cases? If not, there is a risk that the interpretation of §25.1309 may be degraded.
- In fuel tanks, there is a number of latent failures, shown in the SFAR, which could create an ignition source within the fuel tank e.g:
  - loss of pump over-temperature protection
  - loss of bonding (electro-static and lightning protection)
- These types of latent failure are not easy to detect, without, often, requiring to make a physical inspection of inside the tank. How will these latent failures be considered, when assessing the safety of fuel tanks? Clearly, frequent internal inspections of fuel tanks are not acceptable and some means for agreeing certain design practices on existing aircraft may be needed.

4. If there are known to be design practices, which are considered by the FAA to be unacceptable for the existing fleet or for new designs, the SFAR should identify what they are.

Airplane Maintenance Manuals and Instructions for Continued Airworthiness

5. The SFAR proposes the use of the Instructions for Continued Airworthiness (ICA) as the location for the servicing and maintenance instructions for the fuel tank, although to date, the ICA has been used only for structural items. It is recommended that, rather than create a new way of working, the FAA consider:

- use of the Aircraft Maintenance Manual (AMM) for all aspects of fuel tank safety servicing, maintenance, instructions regarding installation issues (wiring segregation etc.), and
- creation, as necessary, of Certification Maintenance Requirements (CMR) to identify those periodic tasks considered essential to meet the Safety objectives defined in the Safety Assessment. This is the conventional method for enabling the detection of safety significant latent failures which would, in combination with one or more other failures or events, result in a Hazardous or Catastrophic Failure Condition.

Unforeseen Fuel Tank System Failures

6. Although the fuel system components within the fuel tank (fuel quantity indication probes etc.) should be designed to minimise the presence of potential spark gaps, there are many operational circumstances, as described in this paragraph of the SFAR, which may cause a spark gap to be created. To prevent this causing a Hazardous failure condition, it is important to take the necessary precautions to prevent the existence of sufficient electrical energy in the tank, causing an arc of sufficient energy to ignite fuel vapours. Somewhere, this energy level needs to be identified - perhaps it will be given in the ignition source AC. This is the 'Intrinsic Safety' approach and it does not rely on the lack of a spark gap in the tank. So that the methods of complying with the objectives of Intrinsic Safety can be understood by all Applicants for future designs and for compliance with this SFAR, it is recommended that the appropriate intrinsic safety standards are developed and included (or Referenced) in the ignition source AC. At present, it is not clear to those who may need to respond to this SFAR, what level of safety is being sought. From ADs already written, it might be that segregation and shielding of FQI wires may be sufficient protection from external effects, but how will the achievement of the basic intrinsic safety current be determined?

Discussion of the Proposal

7. The CAA agrees in principle with the four areas identified here for the Proposal, but CAA is concerned that the actual wording of the new Rules goes beyond what is stated here. Quote from this Section of the SFAR: "The second area of concern encompasses the need to require the design of future transport category airplanes to more completely address potential failures in the fuel tank system that could result in an ignition source in the fuel tank system."
   This seems to imply that the new design Rules for minimising ignition sources are only intended to be applied to new designs, but the fuel tank safety review requested by SFAR No. XX asks for compliance with the new design Rules FAR 25.98 l(a) and (b). This inconsistency needs to be resolved.
   As mentioned in the earlier remarks, CAA would support separation of the tasks for the in-service aircraft review and the preparation of new design requirements for new aircraft designs. What was originally intended by the SFAR? To apply the new ignition source design Rules to the existing fleet, or not?

Safety Review

8. The proposal outlined here calls for the fuel tank safety review to include a demonstration of compliance with the new FAR 25.98 l(a) and (b) - see comment above - and FAR 25.901(c). There is no mention of the need for compliance with FAR 25.1309, despite a significant amount of discussion about this Rule and how compliance with it may be demonstrated, earlier in the SFAR document **(See 'Existing Regulations/Certification Methods').** Is it intended that the safety assessment techniques of FAR 25.1309 may be used for the fuel tank review or must be used?

9. In this section, there is a statement that previously listed failure conditions must be assumed. When some of the failure conditions listed are single faults and can result in an effect (ignition source within the tank), which could jeopardise the aircraft, how can compliance be demonstrated?

10. The need to consider other systems for their potentially adverse effects on the fuel system wiring is not disputed, but it is worth observing that this element of the task could be potentially huge, given the large number of modifications, which individual operators will have introduced by STC or other approval route. Do the FAA envisage a configuration of fuel tank system wiring, which could be demonstrated to be immune to the worst effect that an adjacent system may cause?

Applicability of the Proposed SFAR

11. The FAA's and JAA's Airworthiness Codes recognise a gradation in the level of safety precautions, which can be taken, for small, recreational aircraft to the high capacity, long range jet aircraft (Large aeroplanes). FAR/JAR-25 are the Airworthiness Codes for Large Aeroplanes. As proposed, the SFAR will not apply to those aircraft of fewer than 30 seats or less than 7,500 pounds payload. However, unless, there are some valid technical reasons for not including the lower weight aircraft in the SFAR review, all Part 25 aircraft should be reviewed for fuel tank safety, since the potential risks are the same.

Supplemental Type Certificates (STC)

12. It will be relatively easy to identify the STCs, having an involvement in the fuel system design and operation. A number of examples is given in the SFAR. But, on a practical note, how is it envisaged to identify STCs for other systems, which may affect the safety of the fuel tank system, but have functions entirely separate from the fuel or power-plant systems? Even if they can be identified, any review of an aircraft's TC design plus STC effects really should be conducted at the same time. This was the reason for asking about acceptable 'configurations of fuel tank system wiring' in comment 10 above. Is segregation alone sufficient? Segregation plus shielding? Will the new AC 25.981-1A give practical advice?

The Proposed Amendment

13. As worded, it may not be clear that the SFAR No.XX will also apply to STC holders of modifications, which have no involvement with the fuel system, but which could have an effect on fuel tank safety. A possible improvement could be to revise the Applicability sentence to read:

    "1. Applicability. This SFAR applies to the holders of type certificates, and supplemental type certificates capable of affecting the airplane fuel tank system . ..".

    The addition of the words "capable of' extends the applicability from fuel system STCs to all STCs, which could affect the fuel system. The same additional words could be applied to paragraph 2 of the SFAR.

14. The new design requirements of FAR 25.98 l(a), (b) and (c) are welcomed, as a means to highlight the need for a proper assessment of the fuel system safety. It is recognised that further additions to the design requirements could be made in the future, but it is regretted that there has not been any attempt to propose additional design requirements to curb the future use of unsafe design features and recommend more radical ways for improving fuel tank safety.

The SFAR acknowledges that fuel system designs are not necessarily complex. The basic configurations have now been in use, by all manufacturers for some considerable time, with a low probability of catastrophic failure. However, as the configurations are so similar from a fuel tank safety perspective, this may be one area of design, where it would be to everyone's benefit (Authorities and Constructors) to identify a set of design principles and/or Standards, based upon the best known practices. Examples include:

- definition of the maximum electrical energy, which can be tolerated inside a fuel tank (Intrinsic safety). The level of energy allowable should be lower than the level known to ignite a flammable fuel/air mixture by a defined margin.
- definition of the means by which intrinsic safety may be demonstrated.
- definition of the necessary precautions for fuel tank wiring - internal and external - so that intrinsic safety is not compromised.
- identification of the best standards for fuel tank design for the avoidance of electro-static charge build-up: bonding lead design, bonding schemes, diffusers for the discharge of fuel into the tank to avoid excessive charge build-up, etc.
- identification of acceptable explosion proof Standards for electrical equipment, which may be situated in or near the tank.
- definition of acceptable fuel pump design objectives: choice of materials, overheat protection, dry running capability, fault indication etc.

If we are to consider more radical ways for improving fuel tank safety, there are many possibilities to be considered for future designs:

- prohibit the routing of any high power electrical cables through the fuel tank, whether they are in a conduit or not.
- prohibit the location of boost pumps, which have moving parts, inside fuel tanks, where the pump would routinely become exposed to the tank vapour space ('uncovered') in normal operation e.g. auxiliary or transfer fuel tanks.
- encourage the development of FQI systems, which do not need to introduce sources of electricity inside the tank.
- develop TSOs for any generic fuel tank equipment, where there is a need for certain characteristics to be attained e.g. explosion suppressant foam not to be capable of becoming electro-statically charged, FQI probes not to introduce potential spark gaps nor other hazards.

AC 25.981-1X Fuel Tank Ignition Source Prevention Guidelines

15. There is no information in the Advisory Circular (AC), which clarifies how the 'single failure' aspects of the Safety Assessment will be addressed. The AC lists in paragraph 5.d, a number of failures / malfunctions, which have been seen in service, are single failures and which create an ignition source within the fuel tank e.g. "Wear of Teflon sleeving and wiring insulation allowing arcing from wire through metallic conduits into fuel tanks."

    Under paragraph 6.c Ignition Source Failure analysis, there is a statement: "(l)(a) Each single failure, regardless of the probability of occurrence of the failure, must not cause an ignition source."

    In paragraph 6.c(5)(a)5(aa) Failure Conditions, which describes the Safety Analysis assumptions, it states: "The analysis should be conducted considering the deficiencies an anomalies listed in paragraph 5d of this AC ..."

    These three statements are NOT compatible and compliance with §25.901(c) or §25.1309(b) is NOT possible using these guidelines.

16. In paragraph 6.b(2)(c), there is a mention that AC 25-8 will be revised to delete guidance on the acceptable design features for installing fuel pump wires inside fuel tanks. If there is service experience showing this is not an acceptable design, a revision to the rule should be proposed to make this clear, at least for new designs.

17. More information is required on the proposals for showing acceptably low levels of "Spark Energy Limit" and "Filament Heating Energy Limit" (see paragraph 6.b(2)(a)1 and 2). The term 'voltage spark' is not known. What background is there to the choice of 40 volts and 30 milliamperes as the relevant acceptable limiting values?

AC 25.981-2X Fuel Tank Flammability Minimisation

18 There is a significant amount of advice offered here; much of which will assist constructors in their review of flammability aspects of new designs. However the practical implications for Certification are not yet known to JAA and at some stage it could be beneficial to have discussions or receive additional material about the level of 'compliance' expected with the new §25.981 requirement.

Summary of CAA Comments on FM rule proposed in Notice 99-18.

From the above comments, the following significant points emerge:

I. It is considered that the review of the fuel tank safety for the existing fleet should have been conducted separately from any evaluation of new design requirements for new aircraft.

II. There could have been some advantage to this whole process, if the JAA had been involved in the development of these specific proposals. NOTE: The JAA has had some opportunity for commenting on the draft proposals, but not many comments/suggestions have been acted upon.

III. How can single faults, which are known from service experience to have the capability of creating an ignition source within the fuel tank, be shown to comply with 25.901(c)?

IV. Where there is a need to document the necessary actions for Continued Airworthiness, why is it not acceptable to use the existing methods at our disposal (AMM and CMR), rather than implementing new methods?

V. There should be clearer information about the methods by which constructors can show acceptability for the routing of electrical cables within the fuel tank and the means by which 'Intrinsic Safety' can be shown.

VI. There is some indication that the original intent of the SFAR was to introduce new design requirements for new aircraft only. The implementation of the SFAR is in excess of this. An explanation of the reason for the change in philosophy would be useful.

VII. There is concern about how all the STCs which could have an effect on the fuel system can be identified, especially if the STC does not relate to the fuel system or the powerplant installation.

VIII. Following on from the first Summary item, there could be significant benefits from an investigation into what new design requirements could be introduced to improve fuel tank safety. It is anticipated that a number of possible methods could be available, to further reduce the probability of having an ignition source in the tank.